Collegial Collaboration for Safety: Assessing Situation Awareness by Exploring Cognitive Strategies

Anders Jansson, Mikael Erlandsson, Camilla Fröjd & Marcus Arvidsson

[1] Dept. of Information Technology, Uppsala University,
[2] Dept. of Surgical Sciences,Uppsala University, [3] MTO Safety AB

(Anders.Jansson)@it.uu.se
Department of Information Technology, Uppsala University, Box 337, SE-751 05, Uppsala, Sweden

Abstract. Results from cognitive field studies using a method developed for knowledge elicitation in applied contexts are reviewed. A model for verbal probing procedures is presented. The model is used to assess situation awareness in dynamic decision making contexts – colleagues explore each other's cognitive strategies. The objective is to promote a discussion on whether collegial collaboration based on verbal probing procedures for knowledge elicitation of cognitive strategies is a good way to achieve resilience in socio-technical systems. The design of a study to be carried out in an intensive care unit is presented. The domain of interest, the tasks carried out, and the strategies employed by the nurses seem to be available for further analyses. It is suggested that analyses must only be carried out by the personnel themselves, in teams of experienced colleagues, as a way to achieve a safety culture that promotes reporting of incidents in intensive care.
Keywords: Verbal reports, cognitive ergonomics, decision making, knowledge elicitation, human factors, cognitive strategies, verbal probing procedures

1 Introduction

Research in cognitive ergonomics and human-machine interaction often aim for a detailed understanding of how users think and act in specific work contexts and situations. For the purpose of knowledge elicitation in work contexts where the users are highly experienced, there are several methodologies available. The purpose here is to describe the development of a new method, Collegial Verbalization (CV), and how it was used in different applied contexts. We then present a model for verbal probing procedures that can be used to assess situation awareness and cognitive strategies. The objective is to promote a discussion on whether collegial collaboration based on verbal probing procedures for knowledge elicitation of cognitive strategies is a good way to achieve resilience in socio-technical systems.

1.1 Development of a new method: A field-study of train drivers

The CV-method was developed and first used in studies of train-drivers. We first tried with concurrent verbalizations, that is, we asked them to think-aloud while they were driving. We did not prompt them for explanations or descriptions of the driving task, just asking them to think-aloud what came into their mind while they were driving. We soon ran into problems, since the train-drivers quite soon went on driving without thinking aloud. Despite us hinting on this, they very often became silent. This was particularly evident when they were riding out on the route, between two stations. We learned from the interviews that the drivers were balancing different goals in these situations; they had to keep up with the time-table, and at the same time they tried to avoid exceeding the speed limit (Jansson, et.al., 2006). They tried to drive as gentle as possible, with reduced energy consumption and increased comfort. Unfortunately, we were not able to use the same drivers once again in this project, that is, to have them to verbalize retrospectively on their own driving. But since we recorded them driving with three different cameras in the cabin, we had the opportunity to show their driving to some of their colleagues in hindsight. We asked the colleagues to comment on the driving of the target driver, that is, we asked them to comment their driving in the same way we had asked the target drivers to do while driving. First, this seemed to be a good idea because we would get an independent observers opinion about each target drivers' actions. Later, we realized that the target drivers and the colleagues were very close in familiarity with the routes and the train cabs. We started to analyse how close they were in understanding, the strategies they used and the goals they aimed for. It was concluded that the collegial verbalization method served as a valuable complement to other information acquisition methods in three ways. First, it gave a lot more of information than the concurrent verbalization procedures did. Second, it specifically allowed the researchers to scrutinize the hypotheses on non-observable actions with the help of additional participants. Finally, we assumed it gave less subjective data than retrospective verbalizations would have done since the colleagues were not confronted with their own way of driving, they did not need to rationalize their behavior.

1.2 The next step: A case-study of operators on a high-speed ferry

Inspired by the positive results of using colleagues as informants, we decided to further develop the method. After all, it was developed ad hoc as a response to the inability of the train-drivers to think aloud while driving. We now tried to formalize the method further, to allow for reuse as well as scientific examination of the method. The purpose of this study was to better understand what kind of information the method could provide. One of the objectives of this project was to analyse whether there were differences within the crew in terms of understanding the manoeuvring of the ship. This understanding was related to the dynamics of the ship, as well as the surrounding environment in terms of a pre-defined route. Given the opportunity to study a high-speed ferry crew running a vessel between the mainland of Sweden and the island of Gotland, we decided to video-tape the actions and communications of the bridge crew during an entire 4 hour journey. The studies of the high-speed ferry

officers showed that the method we had developed contributed with a new kind of verbal report data which was different from retrospective and concurrent verbalization data. With the ability to compare statements, we acquired inter-subjective data, which is a completely different kind of data source compared to the situation when there is only a single narrator available, which is the case for both retrospective and concurrent verbalization. We also found that there was an overall agreement between the colleagues and their descriptions. The study showed a high correlation on the main series of events. But each colleague also contributed with additional details. A more detailed comparison also revealed that some details stood in conflict between the protocols, indicating misconceptions of at least one of the narrators. Paradoxical as it may seem, however, it is only with the introduction of the CV method that it is possible to discriminate between different forms of understandings, something which can be critical in many domains. Erlandsson and Jansson (2007) concluded that the most controversial issue with the new method is the idea of having other subjects than the target operators performing the verbalizations. With this approach, the colleagues have not been part of the target actions, and are therefore left with some form of interpretation of what they see when they verbalize. It is important to bear in mind, however, that we are investigating operators who are highly familiar with the tasks we study, and that they all have long experiences from the same tasks and systems. The collegial verbalisation method means a shift away from analysing working memory structures to long-term memories. This also means different theoretical assumptions compared to other forms of verbalisation tasks.

1.3 A systematic comparison: A quasi-experimental study of train dispatchers in a train control centre

In the first two studies, the CV-method was used as a substitute for the concurrent verbalization procedure, since we were unable to use this procedure in the field studies. The collegial verbalization method comes to a prize though – the colleagues who make the verbalization have not been part of the activities, and as a consequence, cannot be assumed to have any information from the specific target situation in working memory. However, if we are interested in analysing domain knowledge structures that have been developed over a long period of time, and have been used on a regular basis as responses to the demands that the specific environmental constraints impose on the operators in these situations, it may be interesting to compare the cognitive strategies within a crew or team where all members are highly familiar with the same tasks. We had so far assumed that the collegial verbalization procedure results in less subjective data than one usually gets from using a retrospective verbalization procedure. Switching from target operator to colleague means also switching from information held in working memory to information recalled from long-term memory. Regarding the rationalization and privacy problem, the CV-method contributes with independent data from which the degree of rationalization can be controlled. Having multiple independent observers verbalizing on the same content means we need to focus more on how well the verbalizations of these narrators and the target operators are correlated. We decided to make a systematic comparison between CV and retro-

spective verbalization (RV). The CV-method had so far only been tested on operators of vehicles and vessels. Even though these domains are very different, they share some important characteristics. In both domains, the decisions made and the actions taken are based on direct perception and action, or recognition-based decisions, situations where dynamic properties are evident and apparently important. In order to investigate decisions more based on analytical problem-solving, we turned to the task of supervision and control of train traffic. In the final study, where it was possible to systematically study and compare the CV method with RV, we produced quantitative data showing that the relation between a train dispatcher who verbalized on his or her own video and a train dispatcher who verbalized on the colleague's video is quite close. Comparing the total amount of protocol data from each verbalization showed that both CV and RV resulted in protocols of rather equal size, suggesting that colleagues are able to produce as much data as the person who were part of the studied events (Erlandsson & Jansson, 2013a). This is without considering any qualitative differences. Both the target operator and the colleague are producing verbal protocols of the same intensity as a response to the actions taking place. The relation between shared and non-shared topics for each verbal protocol showed that the amount of shared topics between the retrospective and collegial protocols is quite high. However, the narrators did not necessarily interpret the actions in the same way. On the contrary, they sometimes have different explanations for these actions, indicating differences in understanding, either of what is going on in the video, or of whether the actions exhibited by the target operator are relevant actions and behaviour in this situation or not. This information is may be as important as any information showing the similarity between colleagues and target operators. It casts light over the fact that the method of collegial verbalisation may have its most interesting area of application in the domain of human factors, looking for different understandings of situations.

2 A model for verbal probing procedures in applied contexts

The use of the collegial verbalization method shows that, if colleagues are close enough in familiarity with a specific task and system, they can verbalize strategies and other non-observable behaviours to the extent that it is possible, not only to use these report data for the purpose of general discovery of psychological processes, but also for the purpose of verification of the result of the those processes. This is perhaps the main contribution of the collegial verbalization method. This fact makes it necessary to discuss the degree of familiarity and expertise when specifying the underlying theoretical model of the verbal report generation. Here we propose that the report generation model suggested by Ericsson and Simon (1980; 1984) is augmented to cover different degrees of expertise and familiarity with the task under investigation. Thus, we propose a division in terms of concurrent probing, immediate retrospective probing, long-term memory (schemata) retrospective probing, long-term memory (schemata) collegial probing, and finally domain expert probing (Erlandsson & Jansson, 2013b). A model based on this division will make it possible to have explicit predictions and hypotheses regarding verbal reporting, including degree of familiarity

with the task. Figure 1 below shows a model for predictions and hypotheses. The combination of having a target operator that can be probed concurrently (working memory) and in retrospect (working memory and long-term memory), and a colleague that can be probed based only on his long-term memory will make it possible to combine different sorts of investigations.

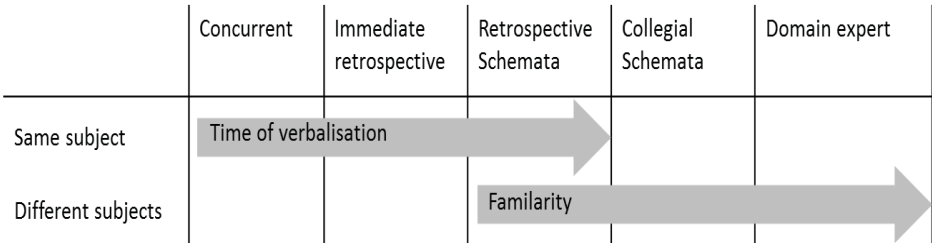

Fig. 1 Verbal probing procedures in relation to time and familiarity

3 Collegial collaboration for safety

Practitioners and their colleagues develop expertise in close relation to their work tasks. This effect not only what they do in specific situations and contexts, but also how they do it, i.e. their cognitive strategies. Some of these strategies are non-observable and knowledge elicitation in the form of collegial verbalizations has the potential of conveying information between colleagues on how to approach specific situations. By having close colleagues sharing each other's cognitive strategies, we believe there is a possibility that the team start develop proactive thinking in order to avoid non-safe interactions with technical equipment and suboptimal working procedures due to organizational demands. In a new project we plan to develop the method of collegial verbalization into collegial collaboration. The purpose is to evaluate whether this knowledge elicitation procedure can be used as a basis for exploring how colleagues can learn from each other. The studies will take place at an intensive care unit (ICU) at Uppsala university hospital. The ICU environment and organization will be thoroughly examined and a standard criterion for the ICU care bedside, with regard to the 5 care tasks and 6 safety threats described below will be established by interviewing the ICU management. We will use this criterion as a benchmark against which we will analyse our results. Fifteen nurses and 15 assistant nurses will be consecutively included in filming and verbalization. Five typical ICU situations where nurses perform patient care tasks will be studied: Nursing the ICU patient; Nursing interventions; Taking patient's vitals; Medication administration; and Preparing patient for/returning from intra-hospital transportations. These tasks are chosen because they are the most common situations in the ICU and the same safety threats occur repeatedly in these situations.

There is little likelihood that we would capture an adverse event on film. Therefore we will analyse the care tasks in relation to risks for 6 common safety threats. The safety threats are chosen based on a review of incidents reported at the ICU 2008-2012, ICU safety literature (Garrouste-Orgeas et al., 2010) and indicators from the Swedish ICU register (SIR): Tube dysfunction, errors administrating medications, accidental removal of lines/drains/tubes, failure to correctly handle ventilators, suction devices, and monitors, and non-compliance to hygiene-, and ventilator associated pneumonia (VAP) guidelines. The material will be analysed by the research team to understand the safety threats (the staff misinterpreting and misjudging situations that have the potential to develop into mistakes and errors on different levels) and to identify possible solutions in terms of monitoring and evaluating safety and minimize / eliminate risks. The peer review verbalization method means that both the staff filmed, and their colleagues, will be used as informants in order to validate and create independent assessments of the actions and behaviours that can be identified through the films. We will film each of the 5 situations 3 times, with different nurses/assistant nurses, a total of 15 film sequences with 15 nurses and 15 assistant nurses. Each film sequence will be 15-40 minutes long. Preliminary analyses show that the domain of interest, the tasks carried out, and the strategies employed by the nurses seem to be available for further analyses. It is suggested that analyses must only be carried out by the personnel themselves, in teams of experienced colleagues, as a way to achieve a safety culture that promotes reporting of incidents in intensive care.

4 References

1. Ericsson, K. A. & Simon. H. A. (1980). Verbal reports as data. Psychological Review, 87, p. 215-251.
2. Ericsson, K. A. & Simon. H. A. (1984). Protocol Analysis: Verbal Reports as Data. Cambridge, MA: MIT Press.
3. Erlandsson, M. & Jansson, A. (2007). Collegial verbalisation – a case study on a new method on information acquisition. Behaviour & Information Technology, 26(6), p. 535-543.
4. Erlandsson, M. & Jansson, A. (2013a). Verbal reports and domain-specific knowledge: A comparison between collegial and retrospective verbalisation. International Journal of Cognition, Technology and Work. DOI 10.1007/s10111-012-0223-x
5. Erlandsson, M. & Jansson, A. (2013b). Collegial verbalization – The value of an independent observer. Unpublished manuscript. Uppsala University, Department of Information Technology.
6. Garrouste-Orgeas, M., Timsit, J.F., Vesin, A., Schwebel, C., Arnodo, P., Lefrant J.Y., Souweine, B., Tabah, A., Charpentier, J., Gontier, O., Fieux, F., Mourvillier, B., Troché, G., Reignier, J., Dumay, M.F., Azoulay, E., Reignier, B., Carlet, J., Soufir, L. OUTCOMEREA Study Group. (2010) Selected medical errors in the intensive care unit: results of the IATROREF study: parts I and II. Am J Respir Crit Care Med. 2010 Jan 15;181(2):134-42. doi: 10.1164/rccm.200812-1820OC. Epub 2009 Oct 29.
7. Jansson, A., Olsson, E. & Erlandsson, M. (2006). Bridging the gap between analysis and design: Improving existing driver interfaces with tools from the framework of cognitive work analysis. International Journal of Cognition Technology and Work, 8, (1), p. 41-49.